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DETAILED DESCRIPTION

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[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention equips inter-electrode [ of a pair ] with an electron hole transportation layer and the luminous layer which consists of an organic material, and relates to the organic electroluminescent element (henceforth an organic EL device) which makes a luminous layer emit light by pouring a carrier into a luminous layer from two electrodes.
[0002]
[Description of the Prior Art] The flat-surface display using an organic EL device and the flat-surface light source are capturing the big spotlight as a next-generation display ingredient, researches and developments are done briskly, and the development for utilization is progressing about the simple dot-matrix display.
[0003] The transparent electrode 12 with which the transparence electrical conducting materials (ITO, SnO2, InO3, ZnO:aluminum, etc.) with which an organic EL device constitutes an anode plate on a glass substrate 10 as shown in drawing 7 were used is formed, and the metal electrode 50 which consists of MgAg for constituting cathode, calcium and aluminum, MgIn, etc. is formed on two or more organic layers (the electron hole transportation layer 14, the luminous layer 16, electronic transportation layer 17) and the organic layer which used the organic material on this transparent electrode 12. And the electron hole poured into a luminous layer 16 from a transparent electrode 12 and the electron poured into a luminous layer 16 from a metal electrode 50 emit light by recombining by the luminous layer 16. As shown in drawing 7 , the light generated in the luminous layer 16 passes a transparent electrode 12, and comes out outside through a glass substrate 10. Moreover, it is reflected with this metal electrode 50, and the light which progressed to the opaque metal-electrode 50 side progresses to a glass substrate side by this, and comes out outside through a glass substrate.
[0004] Moreover, as an organic EL device, what [ not only ] is shown in drawing 7 but the thing which has minute resonator structure as shown in drawing 8 is known. In the organic EL device equipped with resonator structure, the dielectric mirror 40 which consists of multilayers is formed between a glass substrate 10 and the transparent electrode 12 which makes an anode plate, the luminescence light in a luminous layer 16 goes back and forth between this dielectric mirror 40 and metal electrode 50, only the light of resonant wavelength is reinforced, and it comes out to the exterior through a glass substrate 10.
[0005]
[Problem(s) to be Solved by the Invention] However, the rate that the luminescence light generated within such an organic EL device is injected through a glass substrate 10 outside is 1/(2n2) theoretically to the refractive index n in a component. Therefore, it is about 20%, and when a refractive index n is 1.5, the about 80 remaining%, a injection rate guides an organic layer (16 14) and a glass substrate 10, and it will be absorbed in respect of a metal, or it will be emitted from the edge of a substrate.
[0006] moreover, Apply Physics Letter 68 on May 6, 1996 -- in order to obtain the component of a transparency mold, making thin to about 100A thickness of the MgAg layer generally used as cathode, and making this MgAg layer top into wrap structure in an ITO layer is indicated by (19 "Transparent

organic light emitting devices"). However, since the MgAg layer exists as cathode, the permeability of a component is not obtained to about 60%, but the use effectiveness of light is low.
[0007] Moreover, in the organic EL device equipped with minute optical-resonator structure as shown in drawing 8 , since the luminescence light from the organic luminous layer 16 carries out a multiplex round trip between a metal-electrode side and the dielectric mirror 40, the optical loss in a metal-electrode side is still larger, and resonator structure cannot fully demonstrate an optical enhancing effect.

[0008] This invention is made in order to solve the above-mentioned technical problem, and it aims at taking out more efficiently the light generated within the component to the component exterior, and improving luminous efficiency.
[0009]
[Means for Solving the Problem] Between the transparent anode plate electrode which this invention was made in order to attain the above-mentioned purpose, and was formed on the substrate, and a cathode electrode It is the organic electroluminescent element which it has [ electroluminescent element ] the luminous layer which consists of an organic material, an electron hole is poured [ electroluminescent element ] into said luminous layer from said anode plate electrode, and an electron is poured [ electroluminescent element ] into said luminous layer from said cathode electrode, and makes said luminous layer emit light. As said cathode electrode It is characterized by using a transparent transparent conductive ingredient to luminescence wavelength at least.
[0010] furthermore -- this invention -- the above -- it is desirable to have an electronic injection layer between transparent cathode electrodes and luminous layers. If an electronic injection layer is formed, the electron injection from a cathode electrode to a luminous layer becomes easy, electron injection effectiveness improves, driver voltage of a component can be made low, and high luminous efficiency can be realized.
[0011] Moreover, as an electronic injection layer, the ingredient containing the oxide and fluoride of alkali metal or alkaline earth metal is desirable.
[0012]
[Embodiment of the Invention] Hereafter, the gestalt (henceforth an operation gestalt) of operation of this invention is explained based on a drawing.
[0013] [Operation gestalt 1] drawing 1 is drawing showing the configuration of the organic EL device concerning the operation gestalt 1. The transparent anode plate electrode 12 is formed in the top face of a glass substrate 10. As for this anode plate electrode 12, ITO (Indium Tin Oxid), SnO2, ln 2O3, etc. are used.
[0014] Moreover, on the anode plate electrode 12, laminating formation of the electron hole transportation layer 14 and luminous layer 16 which consist of an organic material is carried out. An aromatic amine system ingredient is mainly used for the electron hole transportation layer 14. For example, TPTE (triphenylamine tetramer), alpha-NPB (Bis [N-(1-naphthyl)-N-phenyl] benzidine), etc. are suitable. Moreover, any ingredient of the known reported until now may be used for a luminous layer 16, and the luminescent material from blue to yellowish green luminescence is available.
[0015] An electronic injection layer 18 is formed on a luminous layer 16, and the cathode electrode 20 is formed on this electronic injection layer 18. As for this cathode electrode 20, the transparence electrical conducting material which consists of complex of ITO (Indium Tin Oxid), SnO2, ln(s) 2O3, or these oxides etc. like the anode plate instead of an opaque metallic material is used like before.
[0016] When the transparence electrical conducting material which consists of ITO etc. as a cathode electrode 20 like this operation gestalt is used here, the work function of the transparence cathode electrode 20 is large, and it is difficult for an energy barrier to become high and to pour in a direct electron from the transparence cathode electrode 20 to a luminous layer 16 in a low-battery drive. Even if it uses the ingredient of the comparatively small ZnO system of a work function as a cathode electrode material, it is necessary to impress a quite high electrical potential difference between the cathode electrode 20 and the anode plate electrode 12 for electron injection. If an electronic injection layer 18 is formed between a luminous layer 16 and the transparence cathode electrode 20 and the oxide of alkali

metal or alkaline earth metal and a fluoride (for example, LiF, NaF, LiO2) are formed for this electronic injection layer 18 as an ingredient, the electron injection in a low battery will become easy. Especially, an improvement of the stability of an organic EL device and the life of a component is achieved as this electronic injection layer 18 by forming the fluoride (MgF2, CaF2, SrF2, BaF2) of alkaline earth metal as an ingredient. This is because the fluoride of alkaline earth metal has low reactivity with water compared with the compound of alkali metal, or the oxide of alkaline earth metal and there is little water absorption under membrane formation or after membrane formation. Furthermore, the fluoride of alkaline earth metal is because heat-resistant stability is also improved since the melting point is high compared with the compound of alkali metal. Thickness (divisor of 10A) which covers the front face of a luminous layer 16 completely is suitable for an electronic injection layer 18 in order to reduce in general the thickness of several angstroms - hundreds of A, then the damage which a luminous layer 16 receives in the front face on the occasion of membrane formation (a spatter, the ion plating method, the EB method) of the transparence cathode electrode 20, although it is good. Driver voltage will become high if it is made not much thick.

[0017] As mentioned above, it becomes possible to take out the luminescence light of a luminous layer 16 from the transparence cathode electrode 20 side used as the up electrode of a component by using the transparence cathode electrode 20 as cathode. As shown in drawing 2 (a), in obtaining the luminescence light in a luminous layer 16 through a glass substrate, the guided wave light lost by guiding waves generates the inside of a substrate, but if an up cathode electrode is constituted from a transparent electrode like this operation gestalt, it will become possible to take out luminescence light, without minding the glass substrate which serves as a guided wave component like drawing 2 (b). Furthermore, since the metal electrode which reflects light is not used, the light absorption (optical loss) in the interface of a luminous layer and a metal cathode electrode does not occur. Therefore, it becomes possible to aim at improvement in luminous efficiency also at this point.

[0018] [Operation gestalt 2] Although the above-mentioned operation gestalt 1 shows the configuration which takes out the luminescence light from a luminous layer 16 from the transparence cathode electrode 20 side, it is applicable also to an organic EL device equipped with minute optical-resonator structure. Drawing 3 shows the structure of the organic EL device concerning the operation gestalt 2 equipped with such resonator structure. In addition, the same sign is given to the already explained drawing and a corresponding configuration, and explanation is omitted.

[0019] In the organic EL device shown in drawing 2 , the dielectric mirror 30 which consists of multilayers is formed on a glass substrate 10, the transparence cathode electrode 20 is formed on this dielectric mirror 30 as the luminous layer 16 and electronic injection layer 18 which consist of a transparence anode plate electrode 12 and an organic material as an anode plate, and cathode, and the dielectric mirror 32 which consists of multilayers further is formed on the transparence cathode electrode 20. A minute optical resonator is formed of two dielectric mirrors 30 and 32, among the emission spectrums of the luminescence light in a luminous layer 16, a single or two or more specific wavelength are amplified alternatively, and this organic EL device is emitted by this resonator from the upper part (cathode side) and the lower part (anode plate side) of a component. In making it emanate only from one side of the upper part of a component, or the lower part, let the last layer of the dielectric mirror located in the opposite side be a metal layer a radiation side. In addition, what is necessary is just to consider as the configuration to which light is made to emit from the upper part (cathode side) by using the last layer by the side of the glass substrate of the dielectric mirror 30 as a metal layer, in order to prevent the optical loss by the glass substrate which accomplishes a guided wave component.

[0020]

[Example] The organic EL device applied to the above-mentioned operation gestalt 1 as [an example 1], next an example 1 is explained with reference to drawing 4 and drawing 5 .

[0021] With the component shown in drawing 4 , using a glass substrate 10 as a substrate, this substrate was washed and the ITO electrode 12 was formed by the magnetron sputtering method on it at the thickness of 150nm. On the ITO electrode 12, the electron hole transportation layer 14 was formed in the thickness of 60nm using the triphenylamine tetramer (TPTE) which is an organic material, then the

luminous layer 16 was formed at the thickness of 60nm using the quinolinol aluminum complex (Alq) which is an organic material.
[0022] Next, the electronic injection layer 18 was formed in the thickness of 5A with the vacuum deposition method using LiF, and the ITO electrode 20 was further formed in the thickness of 100nm at the rate of 3 nm/min with the vacuum deposition method.
[0023] Drawing 5 shows the difference in the luminescence brightness by the side of the up ITO electrode to the inrush current consistency (mA/cm2) to a luminous layer 16, and a glass substrate, when plus and the up ITO electrode 20 impress an electrical potential difference so that the lower ITO electrode 12 may be subtracted to the organic EL device obtained by doing in this way. Moreover, when the electrical potential difference of 5V was impressed between two electrodes, green luminescence of the brightness of 10 cd/m2 was obtained from the lower ITO electrode 12 used as an anode plate through the glass substrate 10, and green luminescence of 20 cd/m2 was obtained from the up ITO electrode 20.
[0024] These results show that the light in the luminous layer 16 directly emitted from the up ITO electrode 20 side used as cathode is about 2 times of the light emitted outside through a glass substrate 10. Therefore, by using cathode as a transparent electrode and taking out luminescence light from a cathode side shows raising the luminous efficiency of a component.
[0025] The organic EL device concerning the above-mentioned operation gestalt 2 is explained as [an example 2], next an example 2. In the example 2, first, on the glass substrate 10, the organic EL device of a configuration as shown in above-mentioned drawing 3 formed by turns SiO2 film and TiO2 film with which refractive indexes differ, and formed the dielectric mirror 30 by the spatter. Next, 50nm of ITO anode plate electrodes 12 was formed on this dielectric mirror 30. Next, the luminous layer 16 with a thickness of 40nm was formed using an electron hole transportation layer (not shown) with a thickness of 50nm and Alq using TPTE with the vacuum deposition method. Furthermore, the electronic injection layer 18 with a thickness of 1nm was formed using LiO2, and the ITO cathode electrode 20 was further formed in the thickness of 50nm using ITO. The dielectric mirror 30 finally formed in the glass substrate 10 side and the same dielectric mirror 32 were formed by the spatter on the ITO cathode electrode 20.
[0026] Drawing 6 shows the relation between the luminescence wavelength at the time of driving the organic EL device which carried out in this way and was created by 5V, and the luminescence reinforcement of the light emitted outside. To the organic EL device which is not equipped with resonator structure, also in the organic EL device of the conventional resonator structure using the metal electrode as cathode, the light of specific wavelength is amplified and this is outputted. However, the component of the resonator structure which used the both-sides electrode as the transparent electrode like an example 2 is amplified more nearly alternatively [ resonant wavelength ] to the organic EL device which used the metal electrode for one side like before, and the homogeneous light with small half-value width (width of face until the maximum peak becomes a half value) is acquired. Moreover, the directivity to the upper part of a component and a lower part was shown. Furthermore, the luminescence reinforcement of the homogeneous light acquired with the component of an example 2 is very high as compared with the conventional organic EL device whose one side is a metal electrode so that clearly from drawing 6 . Also from this, he can understand that luminous efficiency improves by the configuration of this example 2.
[0027] In addition, in the above operation gestalt and an example, it is possible as an organic material of a luminous layer not only a low-molecular system ingredient but to use a macromolecule system ingredient like for example, poly para-phenylene vinylene.
[0028] Furthermore, the dependability of a component can be further raised by the wrap, inert gas enclosing a component further, etc. by the protective coat which consists the organic EL device concerning this above-mentioned operation gestalt of an organic material or an inorganic material compound in this invention. In addition, in the closure of a component, the liquid of not only enclosure of inert gas but a silicon system or a fluorine system may be enclosed.
[0029]
[Effect of the Invention] As explained above, by using a transparence electrical conducting material as cathode in this invention, optical loss is reduced and improvement in the luminous efficiency of a

component is enabled. Moreover, if an electronic injection layer is formed between this cathode and luminous layer and this layer is formed using ingredients, such as an oxide of alkali metal or alkaline earth metal, and a fluoride, it will become possible to obtain the reliable organic EL device in which a low-battery drive is possible.

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[Translation done.]

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

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DRAWINGS

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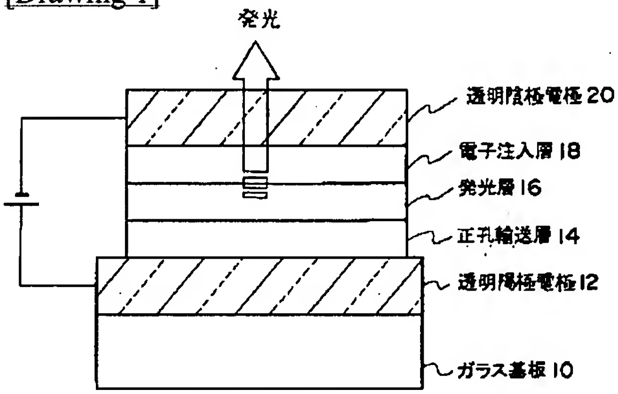
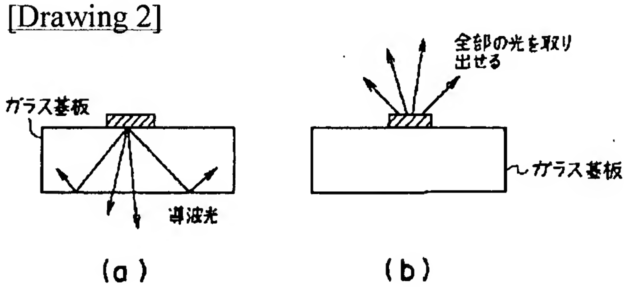
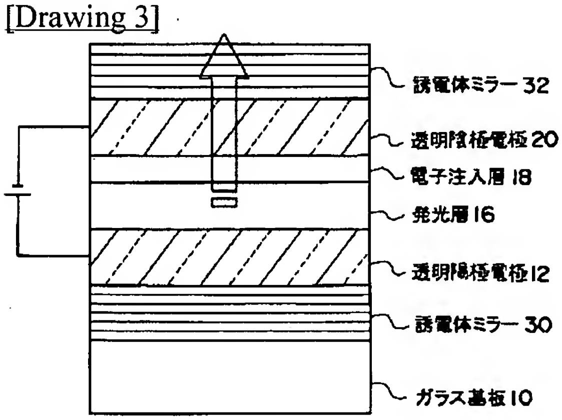
[Drawing 1]



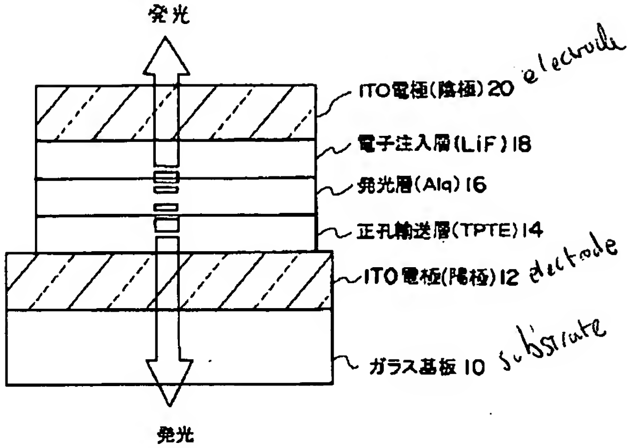

[Drawing 2]



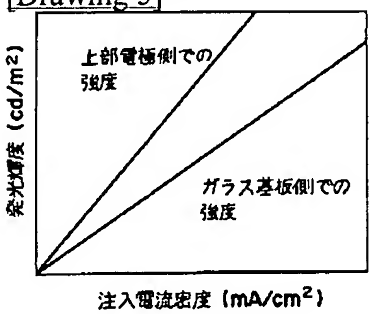

[Drawing 3]



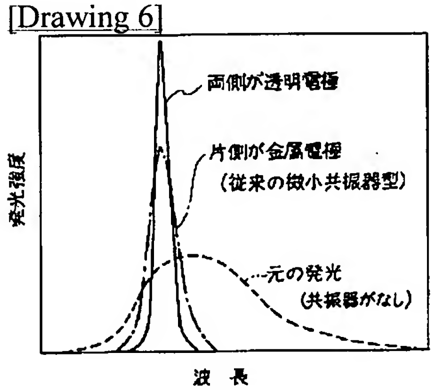

[Drawing 4]



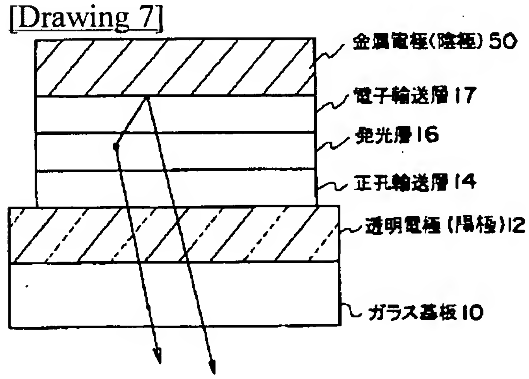

[Drawing 5]



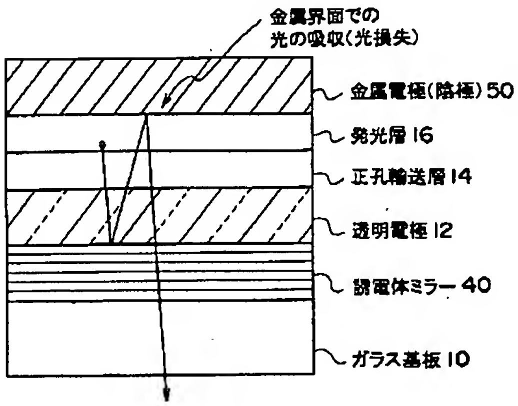

[Drawing 6]




[Drawing 7]




[Drawing 8]




[Translation done.]